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The Clean Development Mechanism – A Tool for Financing Low-Carbon Development in Africa?

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1 Introduction and Background

Climate Change, Greenhouse Gas (GHG) emissions and their mitigation have been widely discussed during the last years. In January 2008, the first commitment period of the Kyoto Protocol came into force which obliges countries listed in Annex B of the Protocol to meet quantitative mitigation targets. The European Union established an Emission Trading System (EU-ETS), which requires large emitters to reduce their GHG emissions. In this way, the European Union's large emitting installations have to contribute to the national emission reduction efforts under the Kyoto Protocol. Both systems, the Protocol as well as the EU-ETS build to some extent on the Clean Development Mechanism (CDM).

The objectives of the CDM are defined in Article §12 of the Kyoto Protocol (3rd Conference of the Parties, Kyoto Protocol), it shall 'assist Parties not included in Annex I [of the Kyoto Protocol] in achieving sustainable development' and it shall 'assist Parties included in Annex I [of the Kyoto Protocol] in achieving compliance with their quantified emission limitation and reduction commitments'. Thus, the CDM has to fulfil a twofold objective, that is to contribute to the sustainable development of host countries and to support the cost efficiency of the Kyoto Protocol.

Against this background, CDM projects generate emission certificates, so-called Certified Emission Reductions (CERs). An installation, e.g. covered under the EU-ETS may choose to reduce its own emissions or, if its own marginal abatement costs are too high, to purchase CERs from CDM projects to meet its emission target. In this way, the CDM contributes to the cost-efficiency of the Kyoto Protocol and the EU-ETS.

The process for the generation and issuance of CERs requires an extensive process ranging from A) the development of a 'Project Design Document' (PDD), B) its validation, C) registration of the PDD under the UN Framework Convention on Climate Change (UNFCCC), D) the development of a monitoring report, E) its verification and finally F) the issuance of CERs by UNFCCC (cp. e.g. Krey, 2004).

Besides the cost efficiency of emission reductions, the CDM shall also contribute to the sustainable development of the host country (3rd Conference of the Parties, Kyoto Protocol, §12.1). Each CER sold represents a financial flow from an Annex I to a Non-Annex I country[i]. Moreover, each CER not only represents a financial flow, it requires an investment into low carbon technologies in the CDM host country. Typically this investment is substantially bigger than the monetary value of CERs (discussed in section 1). This raises hopes that the CDM fosters technological leap-frogging through investments e.g. in renewable energy projects resulting in substantial sustainable development impacts in the host country.

A few CDM host countries such as China, India and Brazil have seen a broad uptake of the CDM and could substantially benefit from this co-financing mechanism. Yet for many CDM host countries the CDM did not fulfil such hopes. Especially in sub-Saharan Africa, the CDM lived to see a very limited uptake. This equally applies to the distribution of CDM projects per country as well as to the distribution of CERs per country (please see Table 1).

This unequal distribution is considered as a major shortcoming of the CDM. The importance of equal distribution was already laid down in the so-called Marrakech Accords, which made the CDM operational. The Conference of the Parties (COP) of the UNFCCC at its 7th session in Marrakech underlined the importance of an *"equitable geographic distribution of clean development mechanism among project activities at regional and sub regional levels"* (Decision 17, 7th Conference of the Parties, Marrakech Accords). Rajesh Kumar Sethi, chair of the CDM Executive Board in 2008, then stated in a press release (UNFCCC, 2008): *"The CDM is operating in close to 50 countries, and is approaching its thousandth registered project with 128 million CERs already issued. Everyone involved can take some pride in those states, but until the potential of the mechanism is realized in the lesser developed countries, especially in Africa, we cannot rest."*

There is an ongoing discourse on the unequal distribution of CDM projects and the limited participation of African countries in the mechanism, cp., e.g., Silayan (2005), Schneider (2007), Castro and Michaelowa (2009), Huang and Barker (2009), Lütken (2011) and Lütken (2012). In this context, two core hypotheses are discussed: the first relates to Africa's potential for climate mitigation projects, the assumption being that the continent's GHG emissions are too small in order to make the region attractive for CDM investors. Sub-Saharan Africa, for example, has per capita emissions of 0.8 tons of CO_2 (WDR 2010). This would imply that, as many regions in Africa are economically not as developed as other regions in developing countries, there are less greenhouse gas emissions and hence less abatement potential in the region.

The second hypothesis is that weak structures and institutions in many African countries impede CDM project development in the region: the CDM as a market-based instrument depends to a large extent on political and macroeconomic stability as well as on robust institutional and administrative capacities. In fact, investments into the CDM may follow similar patterns as other Foreign Direct Investments (FDIs). Sun (2002) demonstrates the importance of a strong institutional framework for FDIs to be picked up at large scale. Therefore, it is assumed that the absence of such enabling conditions leads to limited investments into mitigation projects under the CDM.

There are further barriers to CDM development in Africa. These include, inter alia, the lack of appropriate CDM methodologies, which would match the structure of Africa's GHG emissions. This issue, however, is currently being dealt with at the regulatory level. Furthermore, due to uncertain future of the Kyoto Protocol, there is a general reluctance to invest into the CDM. In 2010, for example, the market volume of the primary CER market fell by almost 50 percent from the previous year, which was preceded by two-digit annual declines in the last three years (12 percent in 2008, 59 percent in 2009, and 46 percent in 2010). 2010's market value of approximately $1.5 billion marks a record low value since the entry into force of the Kyoto Protocol in 2005 (World Bank, 2011).

This article explores the limited uptake of the CDM in Africa by reviewing the above hypotheses. Section 1 looks at the geographical distribution of CDM projects worldwide, with a special emphasis on Africa's low share in the mechanism. This is done by focusing on the limited share in terms of contribution to sustainable development, carbon revenue flows and investments in low carbon technologies is discussed. Section 2 takes up above-mentioned two core hypotheses: GHG abatement potentials are analysed as well as institutional hurdles and barriers to CDM development in the region at the example of eleven selected LDCs in sub-Sahara Africa. The evaluation of the abatement potential is limited to analysing the 'theoretical abatement potential', i.e. without taking factors such as feed-in capacities of the transmission grid into account. Institutional capacities are assessed by evaluating selected economic- and CDM-related indicators. Section 3 evaluates some of the current initiatives and approaches to fostering Africa's involvement in the carbon markets. The article concludes with an outlook on the continent's prospects on using the CDM as a tool for establishing low carbon development.

2 State of the CDM worldwide and in Africa

2.1 Performance of CDM Projects in Africa

On a global scale, the CDM has been expanding rapidly since 2006. To date, 3,577 CDM projects have been registered with the CDM Executive Board (CDM EB). A total of 6,725 CDM projects are currently in the CDM pipeline (i.e. registered and under validation). These projects yield significant impacts: by 2012, CDM projects will result in 2.73 billion issued CERs. But these projects do not only generate CERs, they have also resulted in a total investment of 316.63 billion USD[ii] in low-carbon projects and lead to a total of 288,944 MW installed capacity (all data UNEP RISOE, 2011). The CDM was very successful in delivering cost-efficient emission reductions which can be used by Annex I countries and installations covered under the EU-ETS for their emission reduction compliance.

The CDM's success in Africa, however, has been very limited so far. The bulk of the CDM projects has been conducted in emerging economies such as China, India, and Brazil. Today, there are 179 African projects in the CDM pipeline only, making up for 2.62% of the total number of CDM projects globally. Table 1 below shows the current distribution of CDM projects per country and CERs per country.

Table 1: Distribution of CDM Projects and CERs per Country					
Distribution by Nr. of Projects			Distribution by kCERs		
Country	Nr. Projects	Share (in%)	Country	kCERs/yr	Share (in%)
China	2,813	41.83%	China	1,496,046	54.8%
India	1,735	25.80%	India	418,255	15.3%
Brazil	358	5.32%	Brazil	166,249	6.1%
Vietnam	199	2.96%	South Korea	105,416	3.9%
Mexico	181	2.69%	Mexico	63,221	2.3%
Rest (w/o LDCs)	1,363	20.27%	Rest (w/o LDCs)	464,276	17.0%
LDCs	76	1.13%	LDCs	14,802	0.5%
Totals	6,725	100.00%	*Totals*	2,728,265	100.00%
Source: Calculated based on UNEP RISOE 2011 data					

The findings above are also illustrated by the graphs presented below, cp. Figure 1 and Figure 2. Both graphs show the dominance of the big CDM players: China, India, Brazil, Mexico and Vietnam make up for 78.6% of worldwide CDM projects.

Apart from the number of projects, the amount of CERs is relevant, as it relates to the size of the projects in terms of emission reductions. These data show the amount of carbon revenues generated in each country, the underlying investment as well as the projects' sustainable development impacts, e.g. the amount of renewable energy provided. China, India, Brazil South Korea and Mexico make up for 82.4% of worldwide CER supply.

Figure 1:

CDM Distribution by Nr. of Projects

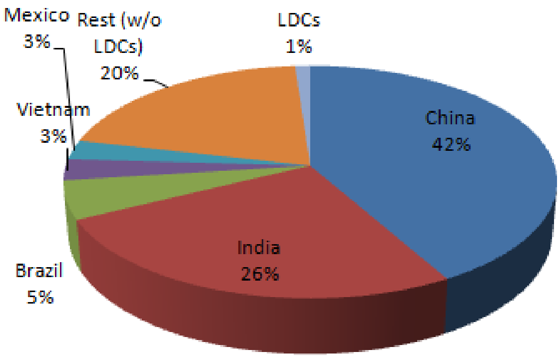
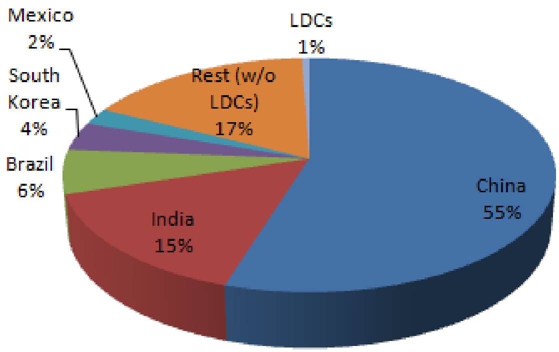


Figure 2:

CDM Distribution by Nr. of CERs



However, the above analysis neglects that some of the big players such as China and India have more citizens than, for example, African Least Developed Countries. Hence, the analysis was extended by a consideration of the total population of CDM countries. Therefore, the total amount of CERs that will be issued up to 2012 was divided by the total of countries' population. This approach allows for normalizing the current distribution of CDM impacts, cp. Table 2.

Table 2: Distribution of CERs per Capita			
Ranking	Country	kCERs2012	CERs/Citizen
Selected Top Countries			
1	Qatar	13,766	8,11
2	Guatemala	7,100	4.86
3	South Korea	105,416	2.15
4	Chile	34,770	2.01
5	Azerbaijan	16,545	1.81
9	China	1,496,046	1.12
12	Brazil	166,249	0.87
21	Mexico	63,221	0.56
35	India	418,255	0.35
African Countries and LDCs			
15	Bhutan	503	0.72
28	South Africa	21,954	0.43
29	Tunisia	4,322	0.41
31	Swaziland	451	0.38
42	Nigeria	36,066	0.23
43	Mauritius	279	0.22
43	Mauritius	279	0.22
45	Lao PDR	1,291	0.21
46	Egypt	16,142	0.20
56	Ghana	2,474	0.10
57	Cambodia	1,226	0.09
58	Libya	573	0.09
62	Côte d'Ivoire	1,263	0.06
63	Uganda	2,024	0.06
64	Kenya	2,450	0.06
65	Senegal	786	0.06
68	Liberia	187	0.05
69	Yemen	924	0.04
70	Tanzania	1,771	0.04
71	Lesotho	79	0.04
72	Nepal	1,015	0.04
73	Zambia	387	0.03
74	Cameroon	546	0.03
75	Myanmar	1,130	0.02
77	Congo DR	1,118	0.02
78	Rwanda	135	0.01
79	Sudan	367	0.01
79	Sudan	367	0.01
81	Bangladesh	1,381	0.01
83	Madagascar	138	0.01
84	Mali	94	0.01
86	Mozambique	63	0.00
87	Ethiopia	179	0.00
88	Togo	5	0.00
90	Sierra Leone	-	-
92	Equatorial Guinea	-	-
93	Cape Verde	-	-

Table 2 paints a different picture of the Big Players: the top five countries in terms of CERs per capita are Qatar, Guatemala, South Korea, Chile and Azerbaijan. The table also highlights a good performance of the top countries in terms of CERs/country, notably for China, Brazil and Mexico. African Countries and Least Developed Countries occupy the lower ranks. Besides Bhutan which with 0.72CERs per capita scores rank 15, the first LDC is the LAO PD at rank 42 (0.21 CERs per capita). The best African country is South Africa at rank 28 featuring 0.43 CERs per capita. African CDM projects are expected to generate 97.79 million CERs by 2012 (3.58% of global volume).

All in all, a significant underachievement of the African continent as regards CDM performance becomes visible. Moreover, Africa currently holds 2.62% of total projects but will generate 3.58% of total CERs by 2012. This is mainly due to large (in terms of CERs/project) industrial projects in the N_2O / HFC abatement sector. Typically, these facilities are operated by multinational companies not being constrained to national access to finance.

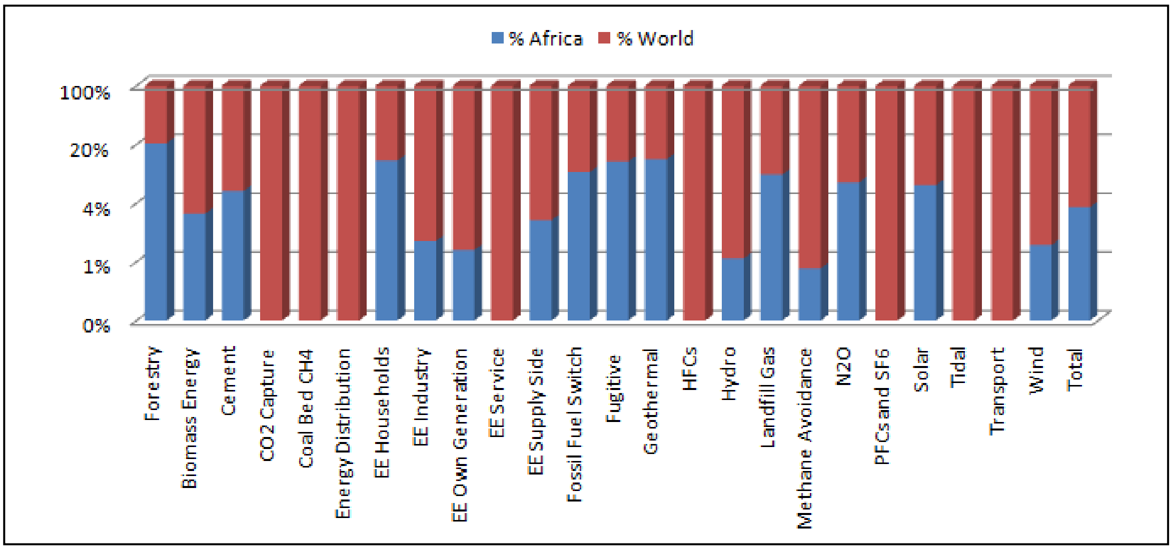
Comparing the CDM performance in Africa on a general level, however, does allow for any conclusions on the performance of specific CDM sectors. This analysis is provided in the subsequent section.

2.2 *Performance of CDM Projects in Africa by Sector*

This section of the paper analyses the CDM performance in Africa on a sectoral level. The following focuses on the overall project pipeline, i.e. including projects under validation. The analysis is limited to the number of projects and does not outline the CERs per sector. Moreover, UNEP RISOE's definition of sectoral scopes is adhered to, grouping CDM activities in 25 categories as this is more detailed and offers a higher explanatory value than the UNFCCC's definition of 15 sectoral scopes (UNEP RISOE, 2011).

Figure 3 illustrates the results of this analysis. For each of the 25 sectors[iii], the total number of projects has been set to 100%. Subsequently, Africa's share of this 100% was evaluated. Please note that the vertical axis applies a logarithmic scale in order to adequately illustrate Africa's shares in the single digit range.

Figure 3: Africa's Share in the Current CDM Pipeline by Sector



Source: Own calculation, based on UNEP RISOE 2011 data

The figures show that Africa has a significant share in the forestry sector with 21% of total CERs generated by reforestation and afforestation projects worldwide. This reflects Africa's outstanding potential in the Land Use, Land Use Change and Forestry (LULUCF) sector. Another prominent sector is the cement sector, 18.6% of CERs generated by cement projects originate from Africa.

Additionally, 8% of fossil Land Fill Gas (LFG) CERs stem from Africa. Though this sector faces remarkable obstacles such as low waste volumes per capita, often unstructured dump sites, or bad waste collection infrastructure, this sector's above average performance may be partly explained by the excellent CDM financing impact: due to the high global warming potential of methane, the typical project may be financed completely through carbon revenues.

Moreover, 6.1% of CERs from geothermal CDM projects will come out of Africa. Due to the high exploration and development costs, such projects are typically not developed by national power companies but by highly specialized companies. These companies often form Public Private Partnerships (PPPs) with national power companies and have excellent access to international financing sources. That is, similar to N2O projects, these projects are not subject to the financing constraints that generally prevail in Africa.

Several sectors such as HFC-, PCF-, and SF6 abatement projects do not exist in Africa. This is due to the fact that the relevant industries are not located on the continent. HFC-23 projects, for example, can only be realized in production sites for refrigerants and in Teflon production sites. Worldwide, 19 such production facilities exist, and none is located in Africa.

Finally, there are important CDM sectors such as Wind (1.8% of worldwide CERs), hydropower (1.0%), and Biomass (2.9%) which are underachieving. These sectors might be constrained by limited access to finance, low electrification rates and by low grid emission factors, especially in the SADC region.

2.3 Investments into CDM Projects by Sector

This section investigates investment costs as background of Africa's performance in the CDM on a sectoral level. In order to determine the discounted investment needs per CER, the following steps were applied:

- First, CDM investment data from the current CDM pipeline was evaluated (UNEP RISOE, 2011). This data was aggregated to the total investment costs for each project type.

- Second, the annual ex-ante estimate of CERs of each project type was multiplied by 10 in order to take an average crediting period of 10[iv] years into account, resulting in the total CER generation for 10 years for each project type.

- Dividing the total investment costs by the total volume of CERs gives an approximation of the investment needs per CER per project type.

- In a final step, the future CERs were discounted based on an annual rate of 10%[v]. The findings are presented in table below, in the very left column.

In order to determine Africa's share of CERs generated up to 2012, the following approach was applied:

- The total volume of CERs generated up to 2012 was determined on a sector level.

- Second, Africa's volume of CERs generated up to 2012 was determined on a sector level.

- Dividing Africa's share by the total CER volume allows for calculating Africa's share for each sector. The results are presented in the column at the very right.

Table 3: Correlation between Investment Needs and Africa's Share per Project Type

Type	Investment Needs (in USD/CER)	Total kCERs up to 2012	Africa's kCERs up to 2012	Africa's Share of CERs up to 2012
HFC Abatement	0.17	476,504	-	0.0%
N2O Abatement	1.71	252,749	16,670	6.6%
Coal Bed CH4	6.28	109,648	52	0.0%
Cement	10.86	33,598	6,266	18.6%
Methane Avoidance	11.53	108,134	1,622	1.5%
LFG Abatement	11.85	202,090	16,224	8.0%
PFC and SF6 Reduct.	13.53	11,796	-	0.0%
EE Households	16.09	5,248	385	7.3%
Fugitive Emissions	21.07	70,005	25,668	36.7%
Forestry	22.07	20,708	4,273	20.6%
EE Own Generation	28.89	203,604	4,057	2.0%
Biomass	33.71	170,073	4,908	2.9%
Wind	51.70	327,979	5,783	1.8%
Fossil Fuel Switch	58.02	174,304	5,714	3.3%
Hydro Power	61.93	441,040	4,542	1.0%
Geothermal Energy	81.38	13,402	812	6.1%
EE Industry	82.45	17,782	400	2.2%
Energy Distribution	97.04	10,471	-	0.0%
EE Supply Side	178.74	61,067	160	0.3%
Transport	269.54	10,039	-	0.0%
Solar (PV & thermal)	307.48	5,573	258	4.6%

Source: Calculated based on UNEP RISOE 2011 data.

It becomes apparent that there is a huge span between HFCs offering the lowest investment needs (0.17USD/CER) and the Solar Power Applications with the highest investment needs (307.5 USD/CER), with average costs of 65.0USD/CER (i.e. the median). Africa's share of projects is higher for those project types where investment needs lie below the median. Overall, the correlation between abatement costs and Africa's share is negative. This means the higher the abatement costs, the lower Africa's share in the project pipeline.

Considering this assessment on a general level, it is concluded that the CDM in Africa does not perform as well as in other regions: Africa's share in worldwide CDM projects, for example, amounts to just 2.62%. This picture changes only slightly when considering all CERs that will be generated up to 2012; Africa's share then represents 3.58%. When normalizing the CERs per capita generated up to 2012, African countries and LDCs occupy the lower ranks. Clearly, the CDM's performance in Africa lies below the worldwide average.

Moreover, investigating Africa's CDM performance shows that some sectors such as forestry (21%), cement (18.6%) and LFG (8.6%) show a good uptake. Yet important sectors such as biomass (2.9%), Wind (1.8%) and Hydropower (1.0%) display a poor performance. Finally, comparing the investment needs per CER with Africa's share per sector shows a negative correlation between high investment needs and Africa's share. Hence in Africa, sectors with lower investment needs are more successful.

In the following, two core hypotheses for a limited CDM uptake in Africa, i.e. missing abatement potential and weak institutional framework, are analysed in detail.

3 Barriers and Obstacles to CDM Project Development in Africa

CDM project development is hampered by a number of factors, as it has been discussed widely (Desanker, 2005; Ellis and Kamel, 2007; Arens et al., 2007, Gunawansa and Kua, 2011, Castro and Michaelowa, 2011). There are, however, few empirical studies looking at concrete criteria and indicators (e.g. Okubo and Michaelowa, 2010).

This section analyses two major barriers: (i) the low amount of the region's GHG emissions and, as a consequence, the lack of abatement potential and (ii) obstacles due to limited access to finance, as well as limited human and technical resources and lack of institutional capacity. The underlying research focused on eleven least developed countries (LDCs) in sub-Saharan Africa: Burkina Faso, DR Congo, Ethiopia, Malawi, Mali, Mozambique, Ruanda, Senegal, Uganda, Tanzania, and Zambia. These countries were selected as they provide, on the one hand, a minimum standard of political and macroeconomic stability. On the other hand, they are, in contrast to South Africa and some of the Maghreb countries, countries where the CDM has not yet succeeded. Moreover LDCs will, as shown in section 4, gain special awareness in the future.

In order to evaluate the technical CDM potential of the countries, existing literature was analysed (De Gouvello et al. (2008) and Econ PÖYRY (2010), complemented by own calculations where appropriate and possible (Arens et al., 2011a). A restraining factor is the limited availability of concrete figures on CDM potentials, especially in sub-Saharan Africa. An important study is de Gouvello et al. (2008), prepared for the World Bank (WB). The WB study's data was amended in several details, such as the application of the country specific grid emission factor and the inclusion of CDM EB's default values for off-grid diesel emission factors. The waste- and cooking stove sector potentials were calculated following an own approach and using country specific data. Further studies on different sectors and countries such as UNIDO (2009), Econ Pyöry (2010) and a number of other specific studies were synthesised in order to get a comprehensive picture of the regions' potential.

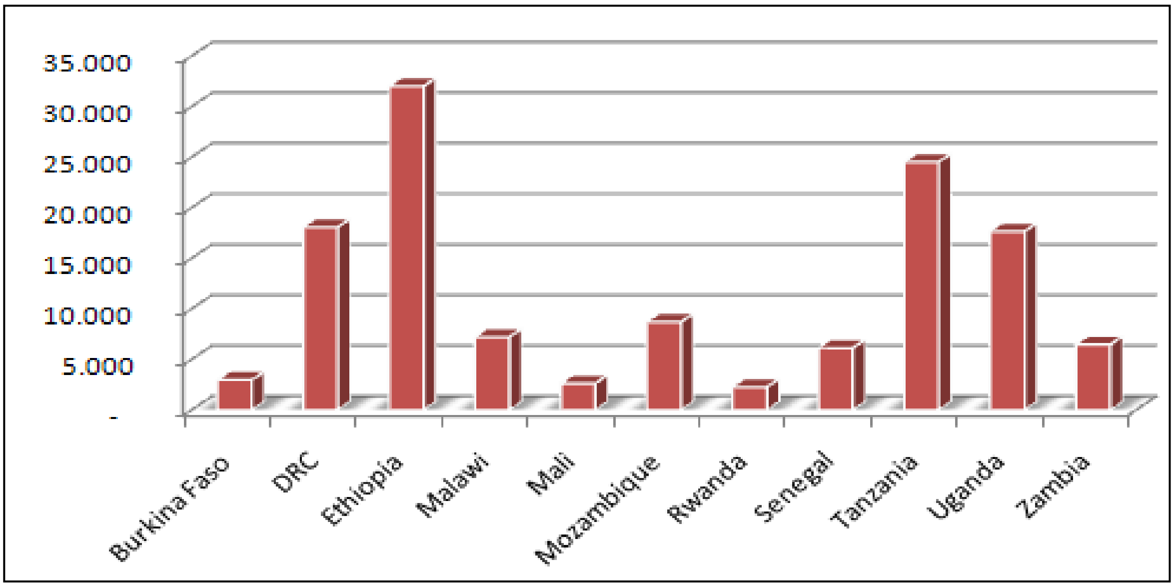
The research on the institutional framework focused mainly on investment climate, technical implementation barriers and the CDM-related infrastructure (Burian et al., 2011). The analysis of these barriers is a challenging task. In order to derive empirically sound results, one would need to apply regression analysis (Keller, 2008). This would allow for testing the hypothesis that a set of criteria such as abatement potentials, financing conditions, or technical infrastructure, determines the actual distribution of CDM projects. As such an analysis was not possible within the scope of our research, the analysis was based on analytical reasoning, on in-depth-interviews of host countries' Designated National Authorities (DNAs) and on expert judgment. Some parts of the work builds on own findings (Arens et al., 2011a), others are based on consultations with the host countries' DNAs, the UN Framework Convention on Climate Change's CDM Database (UNFCCC, 2011c), as well as, inter alia, common country risk rankings, doing business indicators, and competitiveness indices.

3.1 Theoretical Abatement Potentials

Sub-Saharan Africa is not a region in which the need for greenhouse gas reduction measures seems too obvious: with per capita emissions of 0.8 tons of CO_2 (WDR 2010) it is the least GHG emitting region of the world (compare the US with 19 tons per capita). However, because of its large population increase and the often very old and inefficient technology used, there is some potential for sustainable development measures in the region. Tapping these potentials can help both abating GHGs as well as improving the livelihoods of the local population.

Arens et al. (2011) investigated the theoretical CDM abatement potentials for 16 sectors in eleven Sub-Saharan African Least Developed Countries. These are: Burkina Faso, Democratic Republic of the Congo, Ethiopia, Mali, Malawi, Mozambique, Rwanda, Senegal, Tanzania, Uganda and Zambia. Arens et al. (2011) show a significant theoretical abatement potential amounting to a total 128.6 million CERs/yr. **Figure 4** illustrates the emission reduction potential by country in kCERs.

Figure 4: CDM Potentials by Country (in kCER/yr)



A country's overall abatement potential was evaluated by quantifying the theoretical abatement potentials of 16 distinct abatement sectors for each country. The detailed findings are presented in Table 4 below. It is important to note that quite heterogenic approaches were applied for evaluating the distinct sector potentials. Some sectors such as agricultural residues and forest residues (being the largest abatement sectors, covering 59% of the total abatement potential) were evaluated by a generic approach (starting with the amount of agricultural production, their residues, the net caloric value of their production etc.) whereas other sectors such as cooking stoves and Municipal Solid Waste (MSW) where evaluated based on detailed calculations (starting with the investigation of waste volumes for each individual landfill). This results in heterogenic quality of the sectoral assessments.

Table 4: CERs by Sector and by Country (in kCERs/yr)

	Hydropower	CDM Wind Project Potential (y/n)	Geothermal	Biofuels	Agricultural Residues	Sugar Cane	Forest Residues	Wood Residues	Stoves	Distribution Losses	End Use EE	Transportation	MSW	Coal Bed	Mining	Charcoal	Sub-Total by Country
Ethiopia	8.175	N	186	396	11.457	40	8.174	722	1.533	50	130	332	142	-	127	538	32.001
Tanzania	5.471	N	857	342	9.629	100	3.433	902	2.097	20	150	176	140	15	125	1.047	24.506
DRC	1.090	N	-	139	5.720	60	6.029	868	2.561	20	240	147	635	19	20	527	18.075
Uganda	-	Y	2.725	118	4.540	60	6.019	1.403	1.546	-	10	93	72	-	51	1.020	17.657
Mozambique	88	N	-	227	4.850	-	1.486	313	679	-	140	135	53	-	38	686	8.695
Malawi	-	NA	-	77	4.915	100	460	123	720	-	30	62	34	-	20	670	7.211
Zambia	100	N	-	150	3.454	100	664	199	177	10	140	124	63	37	51	1.204	6.473
Senegal	3.035	Y	-	135	1.220	20	-	-	376	240	160	186	93	-	344	312	6.120
Burkina Faso	173	N	-	49	1.574	-	-	-	409	40	550	59	58	-	-	46	2.959
Mali	528	NA	-	25	1.474	-	-	-	278	20	70	48	60	-	-	123	2.626
Rwanda	187	NA	-	52	484	-	849	221	305	-	-	52	33	-	12	69	2.263
Subtotal	1,846		3,768	1,709	49,316	480	27,114	4,752	10,682	400	1,620	1,415	1,383	71	788	6,242	128,586
Source: Arens et al., 2011																	

Among all 11 selected countries, Ethiopia offers the largest emission reduction potential amounting to 32.0 million CERs/yr. The most significant sector is the energetic use of agricultural residues with 11.6 million CERs/yr. Ethiopia is followed by Tanzania (24.5 million CERs/yr), and by the Democratic Republic of the Congo (DRC) (18.1 million CERs/yr). The average theoretical abatement potential per country was found to be 11.7 million CERs/yr.

3.2 Institutional Framework

The institutional framework conditions comprise, on the one hand, structural and institutional issues on a general level, such as investment climate and a functioning infrastructure. On the other hand, the CDM framework was analysed, i.e. personnel, institutions and procedures for processing CDM projects.

Investment Climate

As for the investment environment, one needs to take into account that CDM is an ex-post financing mechanism and CER revenues usually make up only a part of the project financing. This is demonstrated by Table 3 showing the discounted investment needs per CER. For most CDM sectors, the investment need per CER is above the carbon revenues. Therefore, CDM project developers in sub-Saharan Africa have to rely on other financing sources on top of the CER revenues. Thus, in the following, the study countries' financing conditions will be examined in detail.

In order to assess the investment climate of the countries under consideration, five economic indicators were assessed:

- Interest rates (i.e. prime lending rates)
- Country Risk Rating (OECD)
- Doing Business Index of the International Finance Corporation and the World Bank
- Perceived Corruption Index (Transparency International)
- Competitiveness Index (World Economic Forum)

The combination of these indicators paints a comprehensive picture of the countries' investment conditions, as the different parameters complement each other. Some of the indicators are based on a larger sub-set of indicators, which further completes the picture. It has to be noted, however, that certain CDM-related issues are not directly covered in these general indicators, such as the availability of skilled personnel to develop and conduct CDM projects and the local banks' capacity and awareness of the CDM as an investment tool.

As for the lending rates, one has to take into account that banks evaluate risks individually, i.e. they calculate the risk of an investment project and add a case specific risk premium to the interest rate. In order to evaluate financing conditions in the selected LDCs, the countries' prime lending rates were studied, i.e. the average interest rate that commercial banks charge their most credit-worthy clients (adjusted for inflation). Table 5 displays the prime lending rates for the countries under consideration (all sources indicated in the table).

Rates range from 7% in Ethiopia to 17.25% in Malawi in comparison to 5.81% p.a. in China, being the most important CDM country. Interest rates of 12,02% in DRC or 17.25% in Malawi are a very substantial barrier for project financing through debt capital. On the other hand, Ethiopia and members of the Banque Central des États de l'Afrique de l'Ouest (Burkina Faso, Mali and Senegal) show low prime lending rates, which indicates low risk premiums and an independent monetary policy.

Country risk ratings evaluate the risk of investing in a particular country. The rationale behind these ratings is that a country's business environment will affect the generation of revenues, profits as well as the value of assets. In the analysis under consideration, the OECD country risk index was used, as this rating comprises all of the selected study countries (in contrast to the indexes of the standard rating agencies). The OECD (2011) rating offers eight risk classes (0-7), with 0 showing the lowest risk and 7 having the highest risk. The rankings are based on indicators such as payment experience, financial situation and economic situation of the country as well as the country's political risks.

Applying the OECD's country risk rating to the selected countries yields a high risk for all countries under consideration, see Table 5. Five countries are listed in the worst risk class (7) and 6 countries are listed in the second worst class (6). As a consequence, one has to state a high risk of non-payback of loans and, moreover, that the overall economic and financial framework conditions are unfavourable. Most likely only CDM projects with significant profits may be able to attract loan financing in the region.

World Bank (WB) and the International Finance Cooperation (IFC) annually publish an index ranking the ease of doing business (IFC and WB, 2011). For Africa, the ranking ranges from 1 (best) to 46 (worst) comprising the eight indicators. These consist of, inter alia, data on starting a business, the handling of construction permits, registering a property, and procedural requirements for exporting and importing of goods. Table 5 summarizes the results for the eleven study countries. Rwanda, Zambia and Ethiopia are among SSA's best countries. DRC (38th out of 46 countries) suffers from the most difficult doing business conditions followed by Mozambique, Senegal and Burkina Faso ranging in the middle field of SSA.

Transparency International's perceived corruption index ranges from 10 (no perceived corruption) to 0 (high perceived corruption). The index draws upon surveys on issues such as bribery of public officials, kickbacks in public procurement, fraudulent conversion of public funds and questions related to the anti-corruption efforts of the public sector (Transparency International, 2010). The findings for the study countries are summarized in Table 5. Rwanda is ranked best with an overall value of 4 (out of 10), followed by nine countries ranked with 3. DRC scores with a value of 2 out of 10. All in all, the perceived corruption in the selected countries is high to very high, which constitutes a significant barrier for financing renewable energy projects.

Finally, the Global Competitiveness Index (GCI) of the World Economic Forum (WEF) was considered (Table 5). The index defines competitiveness 'as the set of institutions, policies, and factors that determine the level of productivity of a country' (WEF, 2010). The calculation draws on 12 pillars, which comprise, inter alia, institutions, infrastructure, macroeconomic environment, health and education, technological readiness. The index itself is an absolute value ranging from 0 to 7 (best). Worldwide, Switzerland ranks best with a GCI of 5.63 and Chad ranks worst with a GCI of 2.73 (WEF, 2010). Applying the GCI to the study countries shows that Rwanda offers the highest competitiveness with a GCI of 4.0 followed by Senegal (3.7) and Tanzania (3.6). Countries showing the lowest GCI are Mali (3.3) and Burkina Faso with a GCI of 3.2. Overall the competitiveness of the study countries ranges in the lowest 40%.

Table 5: Financing- and Doing Business Indicators

Country	Prime Lending Rate (in % p.a.)	Country Risk Rating[3]	Doing Business[4]	Corruption Value[5]	Competitiveness Value[6]
Burkina Faso	9.60[2]	7	22	3.1	3.2
DRC	12.02[1]	7	38	2.0	N.A.
Ethiopia	1.00[1]	7	10	2.7	3.5
Malawi	17.25[1]	7	16	3.4	3.5
Mali	7.50[1]	6	24	2.7	3.3
Mozambique	2.68[1]	6	13	2.7	3.3
Rwanda	10.11[1]	7	4	4.0	4.0
Senegal	6.80[2]	6	23	2.9	3.7
Tanzania	7.83[1]	6	14	2.7	3.6
Uganda	11.56[1]	6	12	2.5	3.5
Zambia	11.56[1]	6	7	3.0	3.6

Sources: 1: CIA, 2011, 2: BEACO, 2010, 3: OECD, 2011, 4: IFC and WB, 2010, 5: Transparency International 2010, 6: WEF, 2010. Please note: All prime lending rates have been corrected by the countries' inflation, so that the prime lending rate shows the 'real' lending rate allowing.

As Table 5 shows, Rwanda offers the best financing- and doing business conditions, mainly due to comparably medium lending rate of 10.11% and the best Doing Business-Corruption- and Competitiveness Index. Rwanda is followed by Senegal, Zambia, Tanzania and Ethiopia scoring nearly identically. These countries are characterized by good doing business index values and moderate corruption values. Mozambique, Uganda, Mali, Burkina Faso and Malawi are in the middle, while DRC scores worst with its high interest rate and its bad doing business score of 38 (46 is the worst possible score.) All in all, comparing these data with the average OECD risk rating of 4.2 (average of 171 countries) and the average PCI index of 4.5 shows that the above-investigated LDCs typically score below the average.

Technical Implementation / Infrastructure

The lack of electricity transmission and distribution infrastructure can be a significant bottleneck for implementing CDM projects, and many sectors analysed depend on feeding renewable energy into an electricity grid. This applies even when considering limiting factors such as the high Grid Emissions Factors in some of the study countries.

Therefore, existing literature as well as publications with respect to data on total electricity consumption per capita, per year, as well as rural-, urban- and total electrification rate were reviewed.

Table 6: Electrification Rates

Country	El. Consumption (in kWh/capita/yr)	Rural Electrification Rate (in %)	Urban Electrification Rate (in %)	Total Electrification Rate (in %)
Burkina Faso	25	NA	NA	10%
DRC	95[4]	NA	NA	11%[3]
Ethiopia[1]	28	NA	NA	14%
Malawi	99	NA	NA	6%
Mali	62	5.0%	NA	17%
Mozambique	474[4]	NA	NA	9%
Rwanda	25	1.0%	35%	6%
Senegal[2]	158[4]	12.5%	74%	33%
Tanzania	82	2.0%	30%	11%
Uganda	57	5.0%	42%	11%
Zambia	602[4]	NA	NA	18%

Sources: GTZ, 2009a, Renewable Energies in East Africa, (based on data from EAC, 2008 and UNCTAD, 2005), 1: UNCTAD, 2004, Investment Guide 2: GTZ, 2009b, Energy Policy Framework Conditions for Electricity Markets and Renewable Energies 3: World Energy Outlook, 2010 4: IEA 2010, Key World Energy Statistics

The results are presented in Table 6. It becomes apparent that many countries in sub-Saharan Africa have insufficient electricity transmission and distribution capacities. Rural electrification ranges from 1% in Rwanda to 12.5% in Senegal[vi], urban electrification from 30% in Tanzania to 74% in Senegal. The total electrification rate ranges from 6% in Malawi and Rwanda to 33% in Senegal. This means that it will often not be feasible to feed renewable electricity into the grid, as many promising projects sites for renewable energy projects are located in remote areas. But even if a project opportunity is located in an electrified area, it may be the case that transmission sub-stations may not allow for feeding additional electricity into the grid. It is therefore concluded that the low electrification rates are a significant constraint for CDM project development in sub-Saharan Africa.

CDM Framework

In order to measure the status of the countries' CDM readiness, three sets of criteria were studied: first, it was analysed whether the basic CDM structures are operational. Second, the role CDM host countries pursue was examined: are they actively promoting the CDM? Third, the broader context of the national climate and energy policies in the host countries was analysed in order to find out if the CDM is embedded in an active climate policy framework, which will help attracting CDM projects.

The criterion Operational CDM Structures was evaluated through three indictors: first, the basic question whether a Designated National Authority (DNA) is in place was asked. This institution is a prerequisite for approving and conducting CDM projects under the

UNFCCC. Second, it was checked if the country under consideration had registered any CDM projects which is relevant, as a country may notify a DNA to the UNFCCC, but in practice this DNA is not operational, e.g. because the involved Ministries have not specified their approval procedures. A third indicator assessed whether there are binding timelines in place for getting a Letter of Approval (LoA) from the local authorities, showing that the host country is committed to fostering a sound and efficient CDM implementation process.

The second criterion refers to the countries' level of commitment to promoting the CDM. In order to account for such an investor outreach, two indicators were chosen: the first checked whether there is a DNA website available, as an informative internet platform is key because CDM project development which will be financed and planned to a large part from abroad. The second indicator records the (non-) existence of a separate CDM promotion entity. The DNAs as approval bodies must check the quality and climate integrity of the respective project. If a DNA at the same time is tasked with promoting the CDM, this can potentially lead to conflicts of interest; a separate CDM promotion unit can ease this burden. Moreover, an independent promotion agency will be able to better focus on campaigning rather than fulfilling multiple functions at the same time.

The third criterion, finally, looks at the host countries' climate and energy policies. Two indicators were chosen to illustrate this, (i) Submission of Nationally Appropriate Mitigation Actions (NAMAs) under the Copenhagen Accord, as this was regarded to underline the countries' commitment to reduce its national emissions[vii], and (ii) the existence of a national climate policy framework, p.ex. a feed-in tariff. The existing of such a policy is likely to have a favourable impact on CDM project in the country.

The data for this analytical step was gathered through an investigation of the UNFCCC CDM database (UNFCCC, 2011a, 2011b and 2011c as of March 2011). Further information was obtained through interviews of host country DNAs. Still, for some countries, no information was available. The results were then normalized, making sure that each indicator has the same weight. The results of the performance in the respective sub-criteria are displayed in an overall ranking table, see Table 7.

Table 7: Performance of the CDM Framework in selected African LDCs

		Burkina Faso	DRC	Ethiopia	Malawi	Mali	Mozambique	Rwanda	Senegal	Tanzania	Uganda	Zambia
Operational CDM Structures	DNA available	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Existing CDM Projects	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Binding Timeline for LoA Approval	No	N/a	No	No	N/a	N/a	N/a	No	Yes	No	Yes
(Pro-active) Role in CDM project development	DNA Website	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes
	CDM promotion entity	No	N/a	No	No	N/a	N/a	N/a	No	No	Yes	Yes
National Interest in Climate Change Issues	NAMA submission	No	No	Yes	No	No	No	No	No	No	No	No
	National Climate Policy Existing	being developed	N/a	being developed	being developed	N/a	N/a	N/a	Yes	Yes *	being developed	being developed

It turns out that the basic infrastructure to process CDM projects is there: all countries have installed a DNA. However, two countries (Burkina Faso and Malawi have not yet approved CDM projects. Looking at the complete set 'operational CDM structures', Tanzania and Zambia fulfil all three criteria. . Burkina Faso and Malawi show the worst results, as these two countries have a DNA, but they have not approved a single CDM project so far, nor have they introduced a structured process for issuing a Letter of Approval. Two thirds of the countries have set up a dedicated CDM website. Uganda and Zambia are the only countries with separate CDM promotion agencies. Out of the countries considered here only Ethiopia has submitted NAMAs (UNFCCC 2011c). As for the countries' climate change policy, most of the countries have not defined a comprehensive mitigation strategy yet. Ethiopia, by contrast, has set itself the goal to become carbon neutral by 2025.

Conclusions

The analysis shows a significant theoretical abatement potential amounting to a total 128.6 million CERs/yr. The sectoral potentials are quite unevenly distributed, some countries feature only two mayor sectors (Ethiopia), whereas others country potentials are well distributed among several sectors (e.g. Uganda).

Overall, the CDM-related framework conditions in the study region are mediocre. Clear differences between the countries become apparent: while there are a number of countries scoring well at many indicators (Senegal, Tanzania, Zambia), the majority of the host countries faces severe deficits. A

The next section of the paper provides an analysis of the existing regulatory initiatives to improve the regional uptake of the CDM.

4 Initiatives and Approaches fostering the Inclusion of African Countries into the Carbon Market

The CDM's uneven regional distribution, cp. section 2, has been a characteristic feature of the mechanism since its beginning. In order to promote Africa's integration into the Carbon Market, numerous initiatives have been conducted, ranging from classical capacity building to long-term activities supporting specific technologies or sectors (D Byigero et al., 2010; Okubo and Michaelowa, 2010; Arens et al., 2011b). Some activities directly target certain barriers, such as the work of the African Carbon Asset Development Facility (ACAD).

There are also initiatives at the regulatory level, a number of which will be described in the following. First of all, the introduction of the so-called Programmes of Activities (PoA) into the CDM was an important step for project development in Africa. This is because under a PoA, an unlimited number of small, single mitigation activities can be subsumed, and activities can be added even after the program was registered. Therefore, PoAs can mobilize highly dispersed mitigation activities which are, such as the distribution of energy efficient cook stoves.

In this regard, PoAs allow for bringing the CDM benefits not only to industrial facilities but also to households or a small or medium enterprise level. Moreover, only the PoA as such and not each single reduction activity needs to undergo validation, registration and verification. As the transaction costs are fairly independent from scale, PoAs can significantly contribute to lowering this part of the financing burden. Considering that Africa has many regions with a low industrialisation degree, PoAs can therefore be instrumental in bringing forward the CDM in region.

Empirical data indeed show that this is the case. As of September 2010, 56 PoAs had been submitted, whereof 9 were located in Africa, equalling 16% of the global PoA pipeline. This was a major step forward since at the time Africa's share of the conventional CDM pipeline amounted to a meagre 2.6% (UNEP RISOE, 2010). One year later, in September 2011, the global PoA pipeline comprised 121 programmes, 31 of them were located on the African continent. Thus, the African share in the global PoA pipeline rose from 16 % to 25% in just one year. However, the continent's share in the conventional CDM pipeline remained unchanged (UNEP RISOE 2011).

Moreover, several decisions by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) are supporting CDM project development in poor countries. Among other things, the CMP decided to exempt least developed countries from paying the registration fee and share of proceeds at issuance (Watanabe et al., 2008). At its 5th meeting, the CMP agreed to further improve regional distribution of the CDM projects and to develop measures for countries with less than 10 registered CDM projects (Sterk et al., 2010). At its meeting in Cancún, the Parties decided to develop a loan scheme for countries so far underrepresented in the CDM as well as further simplifying the rules for microscale projects (Sterk, 2011). These measures will further ease access of African countries into the CDM.

The CDM Executive Board, the UN body governing the CDM, is also taking steps to facilitate project development in Africa-related sectors. It has, for example, developed, consolidated and simplified a number of Africa-friendly methodologies which are widely applicable. One example is the methodology AMS II.J, which allows for developing CDM projects based on the distribution of Compact Fluorescent Lamps (CFLs). The replacement of incandescent lamps by CFLs can save up to approx. 80% of electricity. The Board agreed on a default factor of 3.5 working hours per CFL, per day. This eliminates the need/barrier to meter the daily operating hours and makes the methodology user friendly. Another example is the methodology AMS I.E, which targets generating emission reductions for the reduction of unsustainable firewood extraction. The energy demand for cooking purposes in rural areas in Africa often is met through firewood collection. Hence, this methodology offers the opportunity to generate CERs e.g. for cooking stove programs. As shown in the analysis of sector potentials, cooking stove programs feature a high abatement potential in Africa.

The Board has also started tackling the issue of suppressed demand. This is of special importance for LDCs, as basic energy needs are often not being met in poor countries. Thus, the demand for energy (and the respective GHG emissions) is suppressed due to a lack of economic resources. The baseline, however, may be established by those emission levels that would occur if a 'Minimum Service Level', e.g. for lighting, would be met (Winkler and Thorne, 2002). At its 62nd meeting, the Executive Board decided on the treatment of suppressed demand in baseline methodologies, defining a minimum level of service based on international and national development goals (UNFCCC 2011d).

The European Union, in its climate and energy package adopted in 2009, installed special provisions for Certified Emission Reductions (CERs) from LDCs. In the absence of an international climate change agreement, certainty on the acceptance of credits from projects that started in LDCs post-2012 is provided until 2020. This is because the EU Emissions Trading System in the period of 2013-2020 will only allow for import of offsetting credits if these stem from projects conducted in LDCs or in countries where a bilateral agreement has been reached. The revised EU Emissions Trading Directive and the EU Effort Sharing Decisions include further provisions to foster CDM project development in LDCs (Council of the EU & European Parliament, 2009).

Conclusion

A number of initiatives and support programmes aim at bringing forward the CDM in Africa. The success of these measures will become visible in the course of the coming years. First achievements are apparent today, as Africa's share in the global PoA pipeline shows. The same applies to newly introduced, 'Africa-friendly' methodologies. The example of the cooking stoves is yet another success story. Preferential access of CERs stemming from LDCs will certainly boost demand for carbon credits from African LDCs. In order to be successful, however, these preferential access measures need to be combined with reducing access costs and removing of barriers impeding CDM project development (Castro and Michaelowa, 2011).

5 Conclusions and Outlook

The CDM has triggered the development of a large volume of emissions reduction projects. The CDM pipeline currently comprises 6,725 project activities generating 2.73 billion CERs up to 2012. These CERs result in a substantial financial flow from Annex I to Non-Annex I countries. Typically, the investment in a CDM project is larger than the monetary value of CERs. A substantial share of these investments is focused on the energy sector. The total installed capacity of all CDM projects amounts to 288,944 MW.

However, the CDM is not widely taken up in Africa. This holds true for Africa's share in the CDM project pipeline (2.62%), for Africa's share in CERs generated up to 2012 (3.58%) and for the normalized CERs per capita, per country. Even though the continent hosts most of the Least Developed Countries, the CDM fails to deliver to deliver sustainable development impacts at large scale on the continent.

Investigating the theoretical abatement potential in eleven selected LDCs shows a wide range of mitigation project opportunities, totalling up to 128.6 million CERs per capita. The most important sectors are agricultural residues (49.3 million CERs/yr), forest residues (27.1 million CERs/yr) and the distribution of efficient cook stoves (10.7 million CERs/yr). It is concluded that despite having the lowest CO2 emissions per capita, Africa offers a wide range of substantial abatement potentials.

Investigating the institutional framework of eleven selected LDCs shows, however, considerable barriers to CDM project implementation. It is evident that these countries are hampered by high interest rates, low electrification rates (limiting the potential of grid connected renewable energy projects), high perceived corruption indices and sub-par doing business- and competitiveness indicators. Clearly, the overall investment framework is impeding the wide uptake of the CDM. This is substantiated by the investigation of Africa's share in the CDM on a sectoral level: Africa has a high share in those sectors that feature low investment needs. In return, it has a low share if the sector has high investment needs. The overall correlation between investment needs and Africa's share is negative.

The recent developments of CDM facilitate its uptake in Africa. A number of small-scale CDM methodologies addressing Africa's CDM potential were developed. The concept of Programmes of Activities allows for grouping large amounts of small emission reduction activities offering new opportunities for Africa. Currently, Africa holds 25% of the worldwide PoA pipeline.

These enabling factors are complemented by the European Commission's decisions of granting preferential access to CERs form LDCs into the EU Emissions Trading System. These measures show first results: Africa's share in registered projects amounts to 1.8% whereas its share in the total project pipeline amounts to 2.6%.

The research presented in this article demonstrates that there is considerable CDM potential across a range of sectors. Future efforts for CDM project development should therefore focus on those potentials that have low investment needs and a high carbon finance impact. This includes projects making energetic use of municipal solid waste, methane avoidance and energy efficiency programmes in households. The theoretical analysis indicates that there is still significant untapped potential. Based on the high carbon finance impact, the CDM may offer sufficient incentives to overcome barriers also in regions having a lesser developed institutional framework.

Moreover, supporting the uptake of other CDM sectors, it is important to be aware of potential institutional barriers. Thus, support should not be constrained to technical assistance for PIN or PDD development but should also develop adequate solutions to overcome the barriers. This could include supporting the set-up of Energy Service Companies, providing contingent grants for technical (non CDM-related) feasibility studies and the development of integrated financing concepts including carbon revenues.

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Annex 1: Calculating the Discounted Investment Needs

Table 8: Calculation of the Discounted Investment Needs per CER

Type	Nr. of Projects	kCERs/yr	MW	Investment	USD/CER	Discounted USD/CER
HFC Abatement	23	81,727	-	83	0.10	0.17
N2O Abatement	76	51,098	-	536	1.05	1.71
Coal Bed CH4	86	38,583	1,184	1,488	3.86	6.28
Cement	49	8,549	-	571	6.68	10.86
Methane Avoidance	686	31,798	508	2,252	7.08	11.53
LFG Abatement	354	53,725	1,301	3,911	7.28	11.85
PFC and SF6 Abatement	18	5,050	-	420	8.31	13.53
EE Households	73	2,989	-	295	9.88	16.09
Fugitive Emissions	47	24,097	328	3,119	12.95	21.07
Forestry	63	4,676	-	634	13.56	22.07
EE Own Generation	472	58,557	10,288	10,394	17.75	28.89
Biomass	770	49,004	9,895	10,149	20.71	33.71
Wind	1,618	143,153	68,348	45,476	31.77	51.70
Fossil Fuel Switch	133	54,877	36,061	19,564	35.65	58.02
Hydro Power	1,763	207,981	70,722	79,138	38.05	61.93
Geothermal Energy	20	5,632	1,125	2,816	50.00	81.38
EE Industry	130	5,257	86	2,663	50.66	82.45
Energy Distribution	22	5,810	-	3,464	59.63	97.04
EE Supply Side	108	59,314	86,642	65,145	109.83	178.74
Transport	42	4,743	-	7,856	165.62	269.54
Solar (PV and thermal)	133	4,507	2,201	8,515	188.93	307.48
Note: Only Types over 100kCERs included. Agriculture, CO2-usage and Tidal was removed						

i Parties that have ratified the UN Framework Convention under Annex I may b found here: www.unfccc.int/parties_and_observers/parties/annex_i/items/2774.php. Non-Annex I countries may be found here: www.unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php

ii Please note this includes registered projects, projects under validation and projects with registration request. But this does not include projects with negative validation results, projects that were rejected by the CDM EB or projects which were withdrawn.

iii Please note, CDM Afforestation and CDM Reforestation have been merged to CDM Forestry.

iv The CDM rules offer a crediting period of 10 years once, or of 7 years twice renewable (21 years in total).

v Based on a discount rate (r) of 10%, a discount Factor (DF) was calculated as follows:

$$DF = \sum_{t=1}^{10} CER_t \, x \, {}^{1}\!/_{(1+r)^t}$$

This approach results in a discount factor 0.614 which was applied to the total volume of CERs of a crediting period of ten year.

vi For some countries no data on rural electrification were available

vii At the time the research was conducted, the Copenhagen Accord was the relevant reference document. The Copenhagen documents were of course later anchored under the UNFCCC umbrella, as per the decision of COP 16 in Cancún, Mexico 2010.